prenanthoides. The characteristic periodicity curve of mean values in these species rises quickly to a maximum in the early part of the season, after which there is a much more gradual decline until the end of the season. Only in *Melampodium divaricatum* and in *Cosmos sulfureus* was there no essential change throughout the season, the former species having a single mode on 10 with the mean slightly above 10 in every collection made, and the latter species presenting a similar constancy, having at all times a half-curve, falling steeply from a strong mode on 5 only to higher values. In most of these species the modes were on the Fibonacci numbers; and while the changes in mean values were gradual and continuous, the appearance of modes on intermediate numbers was relatively rare. In *Anthemis Cotula* 11 and 9 appeared as transition modes between 13 and 8; 9 also appeared momentarily in *Zinnia Haageana*, *Z. tenuiflora*, and *Laya platyglossa;* and 11 and 12 in *Sanvitalia procumbens*. In three heterocarpous species, *Dimorphotheca pluvialis*, *Laya platyglossa*, and *Sanvitalia procumbens*, the plants grown from the two kinds of seeds produced essentially like variation curves. The same thing was true of plants grown in different years and in different environments, the modal numbers and characteristic slopes of the periodicity curves remaining unchanged for the particular species, though the mean values were considerably modified.—GEO. H. SHULL.

Roots of Psaronius.—Since the removal of the great mass of the marattiaceous plants of the Paleozoic to the seed plants, more critical attention has been given to *Psaronius* as the sole evidence of the existence of the Marattiaceae at that early period. Among the structures differentiating *Psaronius* from modern Marattiaceae, the most striking is the difference in the location of the secondary roots in relation to the stem. In the modern representatives of the family these roots bore their way for a considerable distance through the cortex of the stem before they penetrate to the surface. At all points in their course they are sharply marked off from the cortex by remnants of broken-down cells. In *Psaronius* they form a wide zone in the cortex of the stem in which there are no remnants of leaf traces or leaf scars, and no sharp distinction between the root cortex and the parenchyma in the interstices between the roots. STENZEL's explanation of this root layer as homologous with the outer cortex of the Marattiaceae has passed current without question until the last ten years. In 1902 FARMER and HILL suggested that the parenchyma in the interstices of the roots of *Psaronius* might be of the nature of hairy outgrowths rather than cortical parenchyma of the stem.

The question thus raised has been attacked by SOLMS-LAUBACH[19] with convincing results. He worked cheifly with thin sections of fossils (*P. Haidingeri*) from Manebach, supplemented by material from the Museum of Rio

[19] SOLMS-LAUBACH, H. GRAFEN ZU, Der tiefschwarze *Psaronius Haidingeri* von Manebach in Thüringen. Zeitschr. Bot. **3**:721–757. *figs 7*. 1911.

Janeiro. He finds that, unlike the modern Marattiaceae, *Psaronius* has a thin cortex bounded on the outside by a massive hypodermal sclerenchyma layer. From the outer region of this sclerenchyma layer or from the epidermis strands of tissue develop by a secondary activity of the cells, giving rise to a clothing of multicellular hairs on the surface of the stem. Where the secondary roots make their way through the cortex and sclerenchyma layer, they are limited, as in modern Marattiaceae, by a definite epidermis and by a zone of disintegrated cortical cells. But after they have penetrated the sclerenchyma layer, no such clearly marked boundary is perceptible, for here the roots pass downward among the multicellular hairs on the outside of the stem. They are consequently imbedded in the hairs which form a filling tissue between them, closely applied to the stemward sides of the roots. Then, in turn, the hypodermal layer of the cortex of the roots starts into activity. The resulting cells are few on the inner surface of the roots, where the hairs from the stem are in contact with them, while on the outwardly turned face they develop outgrowths similar to the multicellular hairs of the stem. These in turn make an imbedding layer for younger roots whose origin is higher in the stem, and which grow downward over the root surfaces as the first roots grew over the stem. While the hairs of the stem fill the crevices between the first roots and are soon overgrown by them, similar outgrowths from the roots fill the spaces between the successive layers of roots. Each system of hairs stops its growth in so short a time that a meristematic part of the tissue can never be detected. No branching of the filling tissues appears, because of the constant correspondence between the increase in the circumference of the stem and the number of cell rows in the filling tissue, due to the increase in the number of points of origin.

If it were possible to follow a root throughout its course, it would be found to be organized in three parts: a proximal part, in which it breaks its way through the cortex of the stem; a middle part, applied to the filling tissue arising from the stem; and a distal part, in which the subepidermal cortical tissue develops. The so-called "inner" and "outer" roots of *Psaronius* illustrate the two last mentioned portions.

In an attempt to find whether this peculiar development of the outer cortex is present in plants related to *Psaronius*, SOLMS-LAUBACH examined a stem of *Xylopsaronius*. Though its poor state of preservation made definite conclusions impossible, the presence of the root of another plant between the sclerenchyma layer of the stem and the inner roots is strong evidence of a resemblance. In confirmation of this, SCHÜSTER[20] has shown complete correspondence between a well-preserved root system of *Xylopsaronius* and *Psaronius*. The tissue formerly interpreted as secondary xylem in the root of *Xylopsaronius* is in reality secondary filling tissue originating from the cortex like that described in *Psaronius* by SOLMS-LAUBACH. His photomicrograph of

[20] SCHÜSTER, J., *Xylopsaronius*, der erste Farn mit secundärem Holz? Ber. Deutsch. Bot. Gesells. **29**: 545–548. 1911.

the stem is strong evidence in support of the interpretation of the filling tissue as peculiar outgrowths. Nothing comparable to such multicellular hairs on roots has been found in present ferns, although it is possible that examination of tropical tree ferns may reveal traces of similar structures.—GRACE M. CHARLES.

The development of Pyronema confluens.—Believing that the alternation of generations has not yet been satisfactorily worked out in any fungus, CLAUSSEN[21] has completed an extensive cytological and morphological study of the development of *Pyronema confluens*, a form already investigated by HARPER[22]. The spores germinate immediately on being discharged from the ascus. He finds that under favorable conditions any cell of the fungus may develop into a complete plant. In material grown on agar at 20° C. in direct sunlight, he finds that the vegetative mycelium is produced in 1–2 days; the fruit bodies begin to form in 2–3 days; fertilization occurs in 3–4 days and the first ascogenous hyphae appear; after 5 days the recurved tips of the ascogenous hyphae are observable; young asci may be found on the sixth day, at which time 1, 2, 4, and 8-spored asci are present. In cultures under these conditions the fungus completes its development in 7–8 days. CLAUSSEN observed that the younger stages of the fruit bodies often arise from dichotomously branched aerial hyphae, so that they are often stalked. His observations as to the origin of the sexual organs agree in general with the earlier descriptions of DE BARY[23] and of KIHLMAN.[24] The hyphae, which bear the ascogones, and those which bear the antheridia, may arise from the same mycelial thread; the fungus, therefore, is homothallic.

The mycelium consists of multinucleate cells. Protoplasmic streaming was observed in the hyphae, indicating that there is a pore in the cross-walls, connecting the contents of adjacent cells. The hyphal branches which bear the sexual organs are always multinucleate. CLAUSSEN is unable to determine whether or not nuclear division occurs in the ascogone and in the antheridium before fertilization. So far as he is able to discover, the nuclei in the sexual organs are exactly alike. When the sex organs are mature, he observes that the nuclei increase in size, but that there is a more marked increase in the size of the nuclei of the ascogone. Certain nuclei in both male and female organs degenerate before the sexual act. The phenomena concerned in the fusion of the antheridium with the trichogyne, the passage of the male nuclei into the

[21] CLAUSSEN, P., Zur Entwicklungsgeschichte der Ascomyceten. *Pyronema confluens*. Zeitschr. Bot. **4**: 1–64. *pls. 6. figs. 13.* 1912.

[22] HARPER, R. A., Sexual reproduction in *Pyronema confluens* and the morphology of the ascocarp. Ann. Botany **14**: 321–400. 1905.

[23] DE BARY, A., Ueber die Fruchtentwicklung der Ascomyceten. Leipzig. 1863.

[24] KIHLMAN, O., Zur Entwicklungsgeschichte der Ascomyceten. Acta Soc. Scient. Fenn. **13**: 29–40. 1883.